Design and Implementation of Metallic Waste Collection Robot

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Abstract

The accumulation of waste has become a problem in urban city dumps. There are different kinds of waste that affect our environment, for example metallic and plastic waste. Developing metallic waste collection robotic system is a big challenge. There is limited research available about robotic systems that specialize in the collection and processing of waste. In this paper we propose robotic system that can be used for metallic waste collection and processing. This robot is equipped with a metal detector, ultrasonic sensor, control and power unit, and actuators. This autonomous robot can perform tasks such as obstacle avoidance and metal detection.

Introduction

As a result of the accumulation of metallic waste in recent times, researchers are working to find possible solutions to reduce environmental pollution caused by these waste dumps. Some of those solutions are related with robotics, such as Zen Robotic Recycling, which has multiple sensors for accurate analysis. Based on the analysis, the robot can make independent decisions to pick up objects from the waste stream. Zen Robotic Recycling can be used only in recycling factories and some commercial establishments, but it has high-cost and it is non-usable in different environments. We decided to design and implement our own metallic waste collection robot. Some of the factors considered in this work are cost, size, flexibility, weight, and autonomy. The purpose of this work is to detect metallic objects in a specific area and pick them up by using a robotic arm.

There are different kinds of microcontrollers that can be used as a platform for this system. These include Arduino, LilyPad, SparkFun and Seeed Studio. Arduino microcontroller can be programmed using the Arduino programming language. To meet the objective of this work, several sensors such as Ultrasonic sensor, and IR sensor are used. In order for a metallic object to be picked up, the metal detector plays a significant role. There is an IR distance sensor mounted on top of contraption is used in this work for object detection and servomotors that control the movement of robotic arm.

DC motors are also used in this work. The Arduino Motor Shield allows the microcontroller to drive the two-channel DC motor. Speed control is accomplished through conventional PWM, which can be obtained from Arduino PWM output pins. This paper has two main sections, which are methodology and experimental results. Section 2, methodology, describes hardware and software used on this work. Section 3, shows a experimental results this robot.

Software Architecture

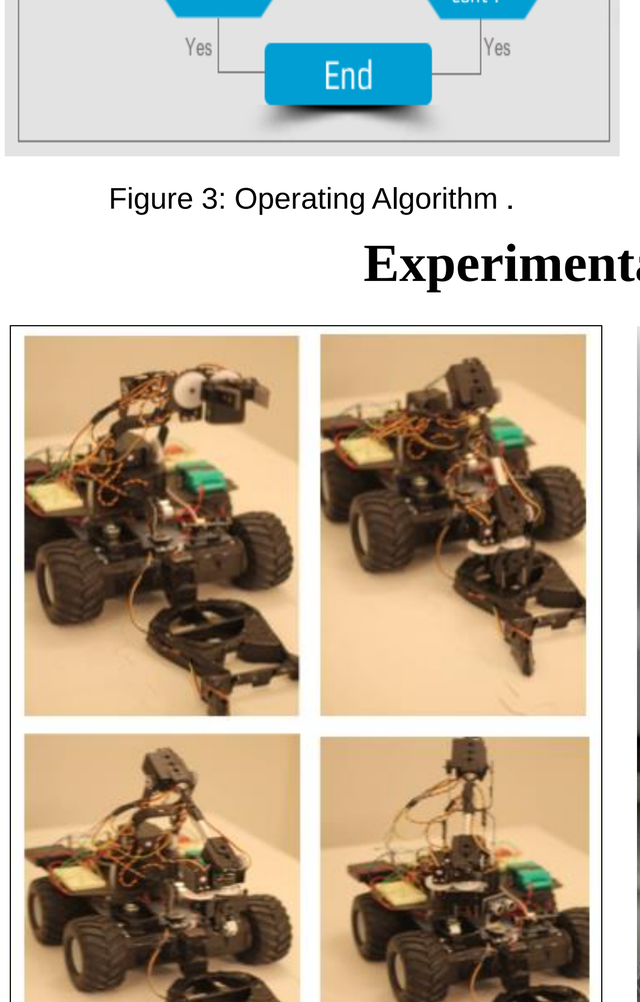

Figure 3: Operating Algorithm .

The general algorithm has the following steps to accomplish the task, they are start, travel, stop, drop, pickup, and end. The program will begin with start step; through this step the Arduino Mega will run and check for pins and then go to the next step, which is travel. During this step, the robot moves and utilizes both the metal detector and IR sensor to check for any object. In case the detector or IR sensor finds an object, the robot will stop and then go to the pickup step to pick the object up. After that, the robot will check if the object is metallic object or not by passing it over the metal detector. In case the object is metallic the robot will go to drop step and drop it in box 2 and increment the metallic counter then check for the limit of metallic object counter. If metallic counter equal to the limit of metallic object counter, the robot will go to end step. Otherwise, the robot will return to the travel step till it finds another object. On the other hand, if object was not metallic, the robot will go to drop step and drop it in box 1 and increment the non-metallic object counter then check for the limit of non-metallic counter. In case if non-metallic counter equal to the limit of non-metallic object counter, the robot will go to end step. Otherwise, the robot will return to the travel step. Figure 3 shows an overview of general algorithm.

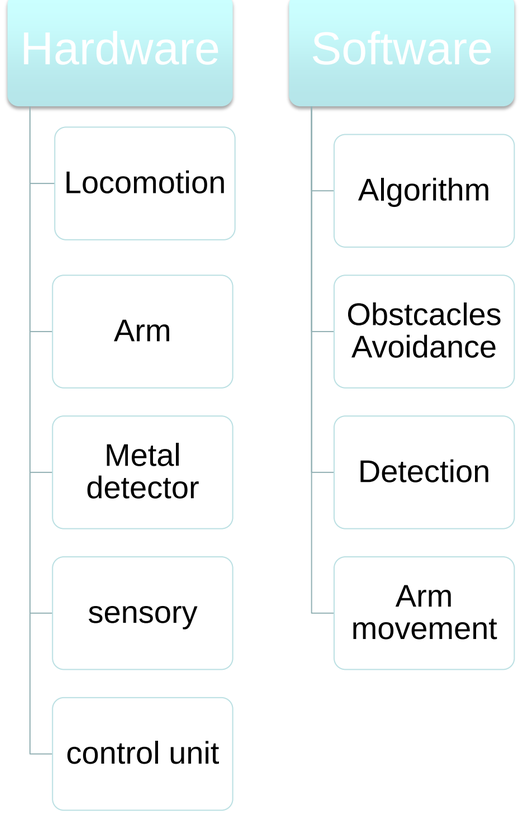

Figure 1: Hardware and Software Modules.

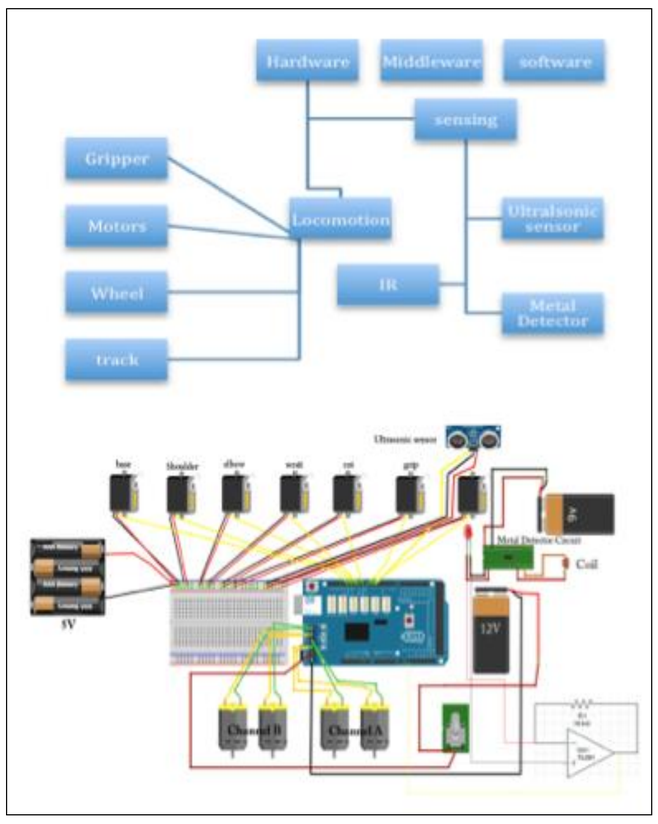

Figure 2: Hardware Architecture Design.

Methodology

This work consists of four modules locomotion, detection, pickup, and control. The locomotion module is equipped with a transport device for transporting the robotic vehicle from a start location to a target location. Locomotion module depends on detection module for moving and stopping. In addition, this work is divided into two important sections, hardware and software. Hardware section contains four main subsections, which are arm, locomotion, metal detector, and control module. While the software section contains three subsections, which are obstacle avoidance, detection, and arm movement. Figure 1 shows working sections that are implemented in this work

Hardware Design

The hardware architecture design is shown in Figure 2. Robot consist of five components Lynx5 Robotic Arm shown in Figure 7, IR Distance Sensor, Arduino Mega 2500 Microcontroller with Arduino Motor Shield, metal detector, and *4WD1* Robot Rover kit. In this work, we utilized above components and built a re-configurable robot. In addition, we designed a contraption and installed it on front of rover to give the robot enough support for the object collection task. Furthermore, we added two boxes on the robot. Box 1 was placed on right side of robot to contain non-metallic objects. Box 2 was placed on left side of the robot to contain metallic objects. In this section, we describe hardware components with more details. Figure 8 shows Arduino mega microcontroller with motor shield that we used to control this robot .

Figure 4: Drop Metallic Object on Box 2 .

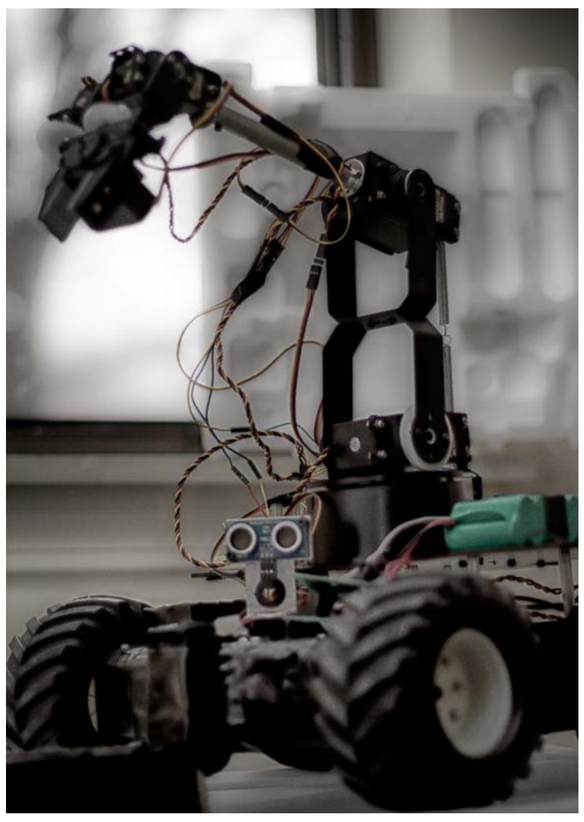

Figure 5: Metallic Waste Collection Robot.

Experimental Results

We have performed different experiments to explain system's ability and its accuracy in doing the task. Figure 4, 5, 6 show different views of Metallic Waste Collection Robot performing the task. We noticed the robot moved forward and then stopped and started moving the arm smoothly to pick it up, and then passed it over metal detector to check if the object is metallic or not. After that, the robot dropped the object in metallic object box. The result of these experiments showed that the robot succeeded in performing object detection, obstacle avoidance, and arm movement. According to the results, the robot preformed the required task efficiently.

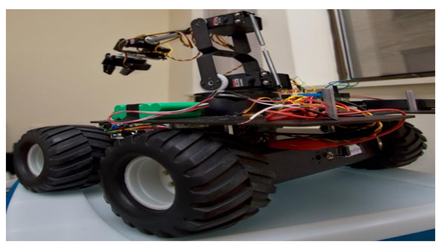

Figure 6: Side view of the Robot.

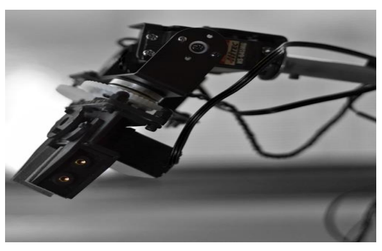

Figure 7: Robot's Arm.

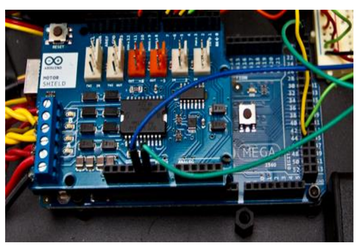

Figure 8: Control Unit.

Conclusion

Our goal was to build a robot that can identify and collect metallic or non-metallic objects in a specific area. We demonstrated the working of this robotic system using a set of experiments. Finally, this modular system can be extended to handle different types of waste.

For more information about this work including working videos, pictures, and code, please visit: www.robobcomes.com